



Watershed Modeling in Support of Water Quality Management of the Currituck Sound

Ana María García

**North Carolina Water Science
Center**

Purpose and Scope

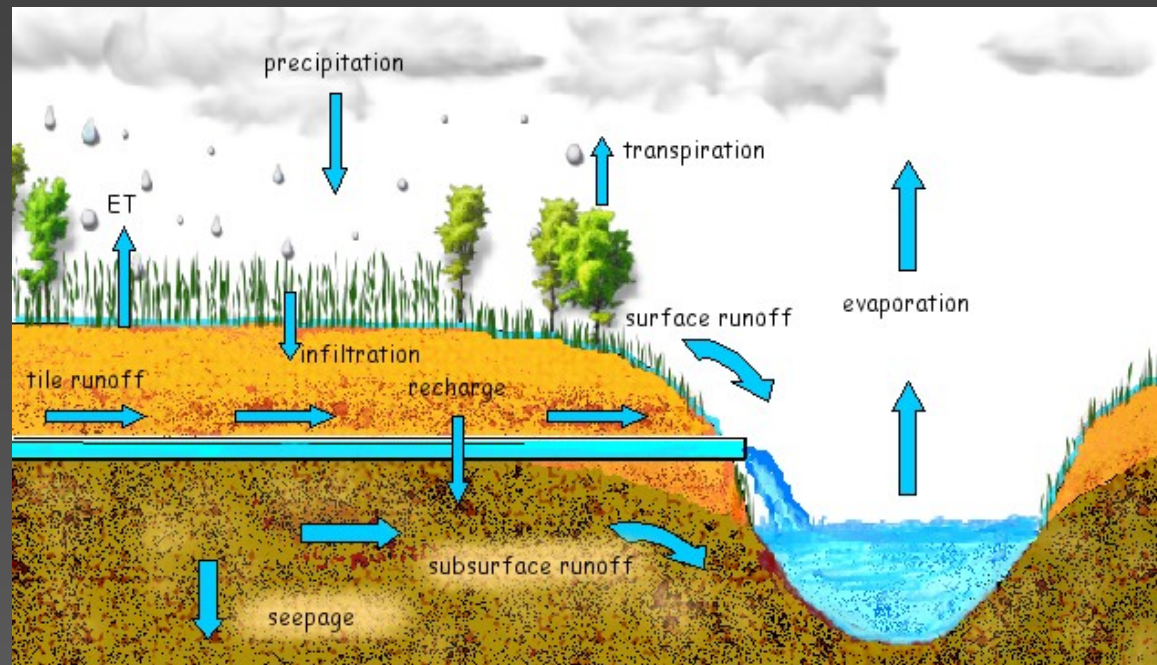
- SWAT was applied to simulate flow, sediment and nutrient transport
 - Tull Creek watershed
 - West Neck Creek watershed
- Water quality parameters of interest included
 - total suspended solids (TSS),
 - total phosphorus (P)
 - total nitrogen (N).
- Load estimates for
 - existing conditions and an alternative scenario.

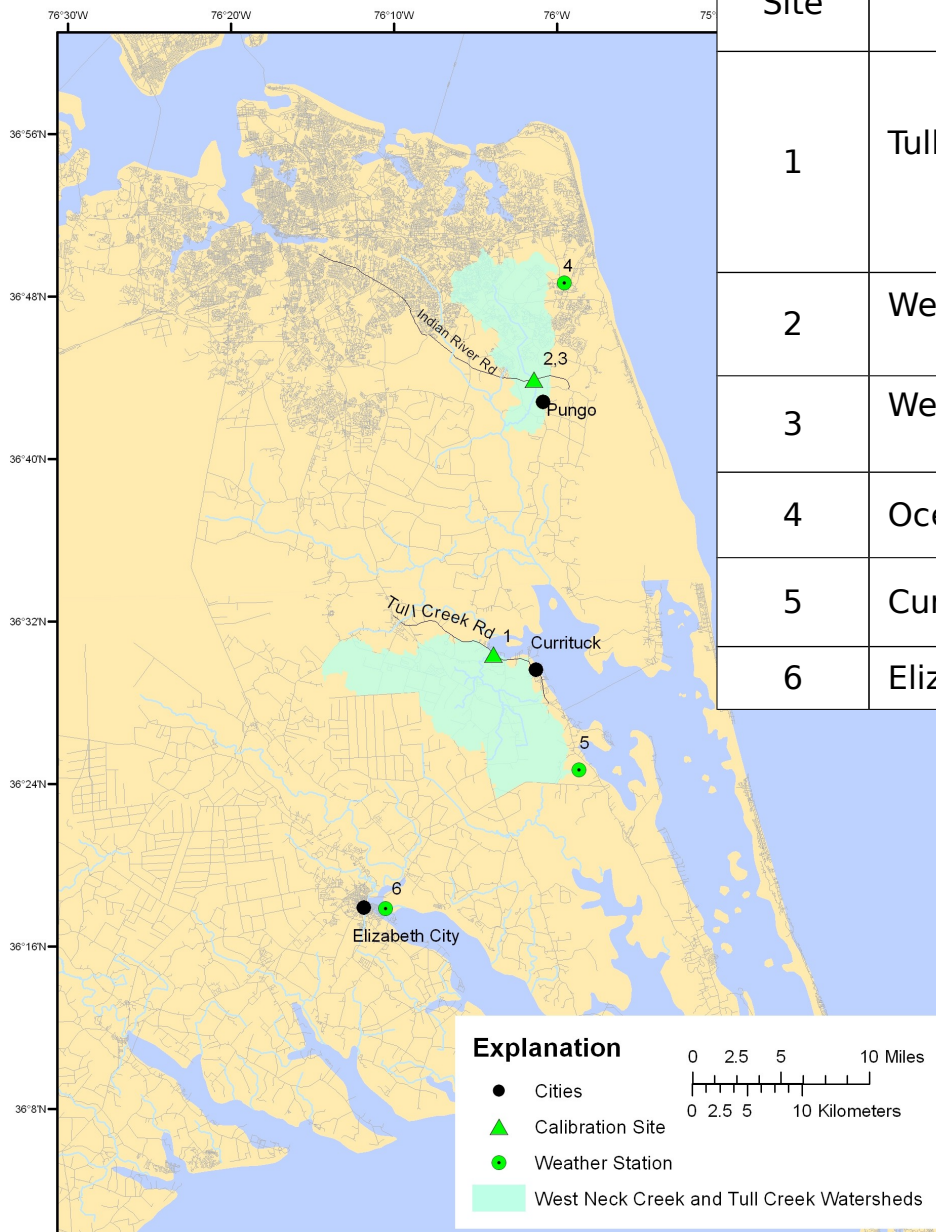
Modeling Procedure

- Model Setup
- Calibration*
 - Hydrology
 - Water Quality
- Simulation of current (06-07) conditions
- Simulation of alternative scenarios

Soil Water Assessment Tool (SWAT)

- Physical, process-based representation of hydrologic cycle and pollutant transport

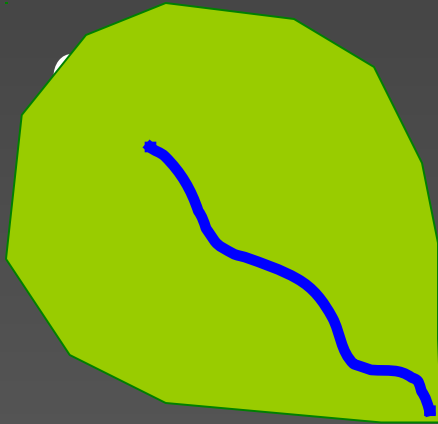




Site	Station Name	Parameters	Period of record
1	Tull Creek at SR 1222 Bridge	Flow	Jan 06 - Jul 07
		Turbidity	Mar 06 - Jun 07
		Nutrients	Jul, 06 to Jun, 07
2	West Neck Creek at Indian River Rd	Flow	Feb 98 to Jul 99
3	West Neck Creek at Indian River Rd	Turbidity, Nutrients	Jun 72 to Jan 06
4	Oceana Naval Air Station	Climate	Mar 45 to pres.
5	Currituck Airport Station	Climate	Feb 04 to pres.
6	Elizabeth City	Climate	Jan 34 to Oct 07

Model Setup

- Watershed segmentation
 - Sub-basins
 - Hydrologic Response Units (HRU)
- Each sub-basin can be associated with a unique matrix of hydrologic



- Landuse Distribution
- Weather Data
- Soil Type

Hydrologic and Terrain Data

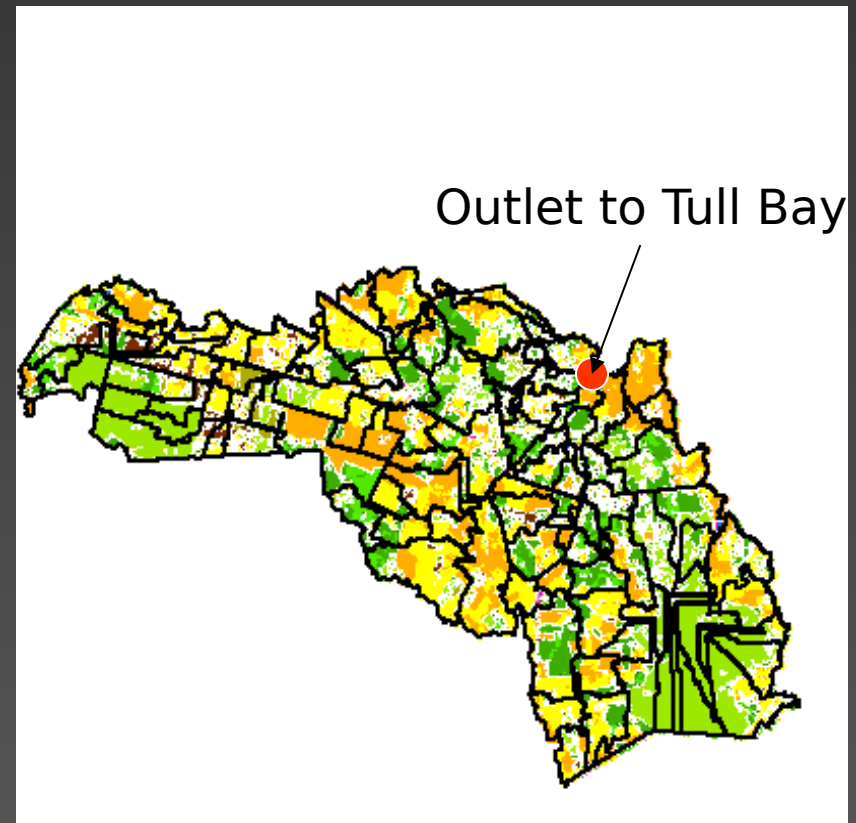
- Land use/cover
 - USGS National Land Cover Dataset (NLCD)
- Soil Map and Database
 - NRCS State Soil Geographic Dataset (STATSGO)
- Weather
 - NC State Climate, NCDC
- Topography
 - LIDAR
- Flow and Water Quality
 - USGS Flow gauges, Water Quality data

Model Calibration

- Quality Checks - Methodology
 - Progressive calibration
 - Hydrology first, then water quality
 - Upstream sites are calibrated first
 - Calibration at sites with predominant land use
- Criteria
 - Graphical comparisons
 - Coefficient of determination, R^2
 - Nash-Sutcliffe model efficiency coefficient

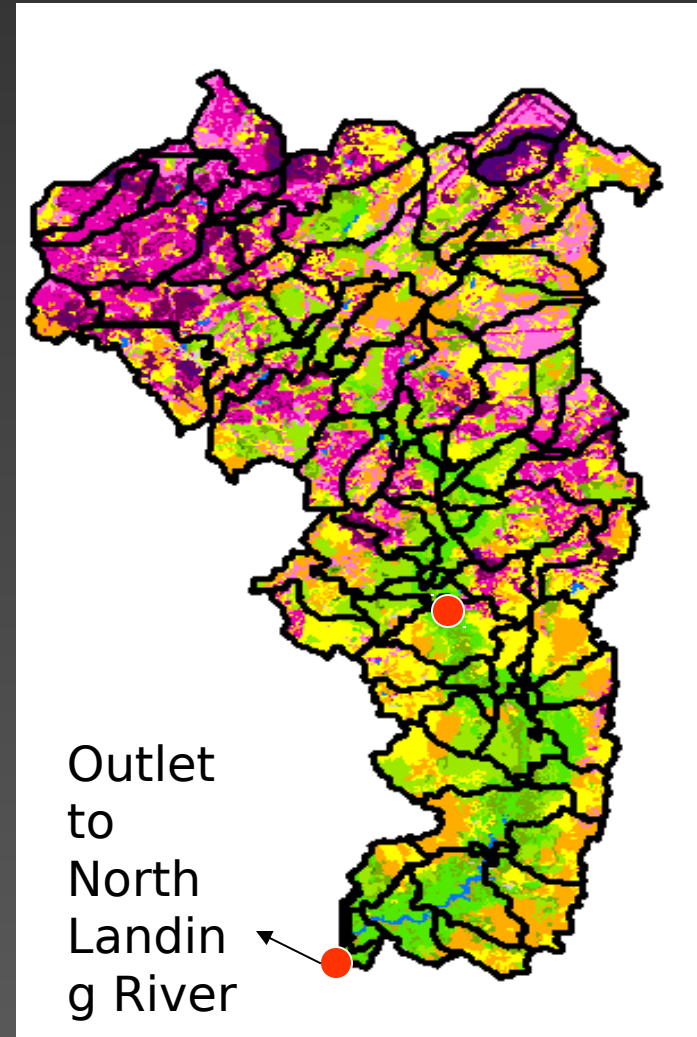
Tull Creek SWAT Model

- 116 sub-basins (0.45-476 ha)
- 150 km² drainage area
- 55% in agriculture*
- 43% marshland and forest*
- Predominant soils are very poorly draining



West Neck Creek SWAT Model

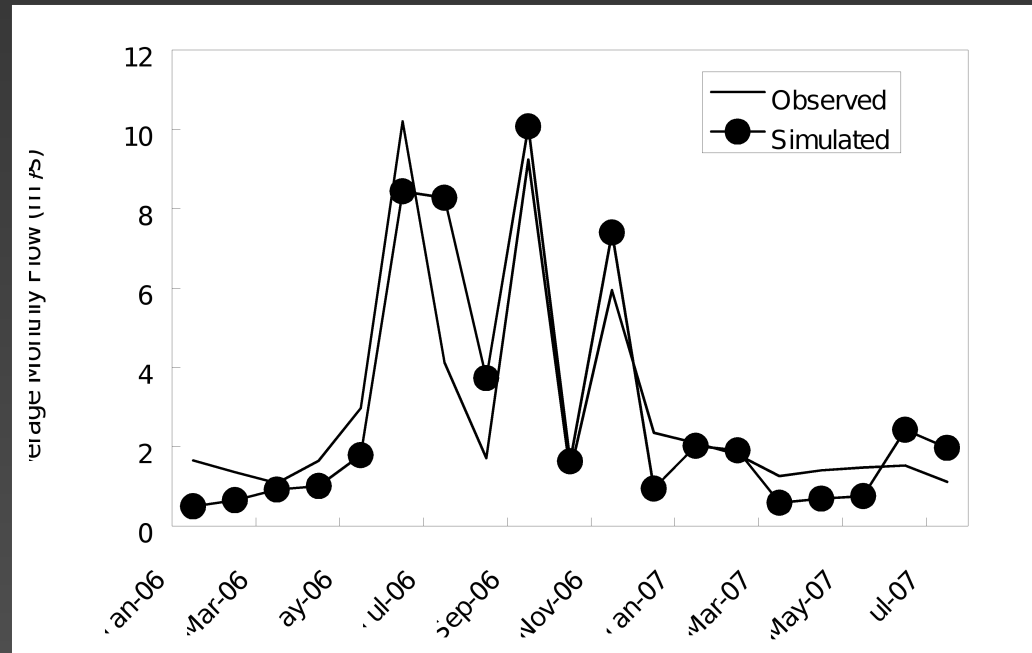
- 93 sub-basins ranging in area from 0.88 ha. to 318 ha
- Total delineated drainage area of 88 square kilometers
- Significantly urban (36 %) and agricultural (37 %).
- Wetlands and forest (27 %) buffer the southern portion

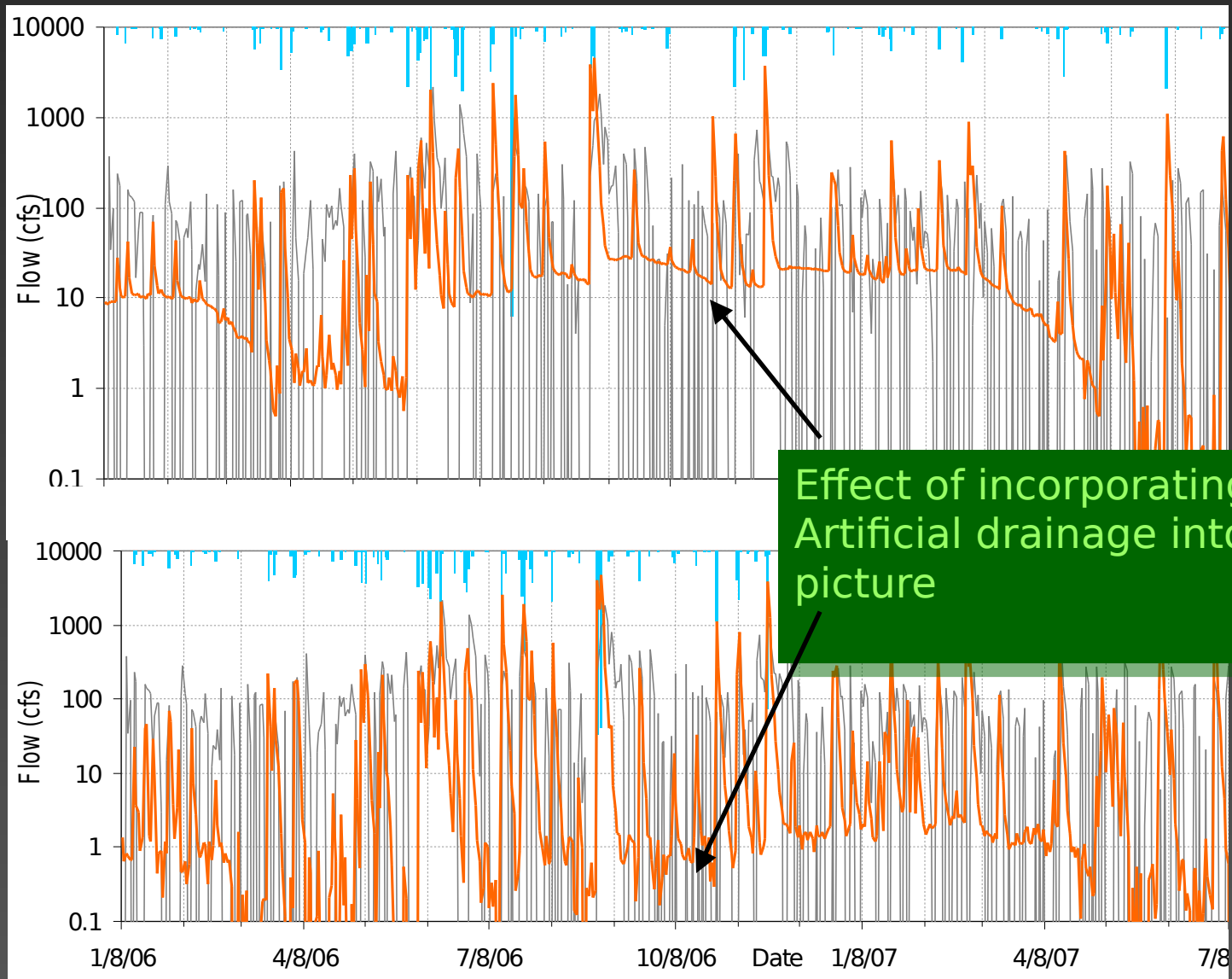


Tull Creek Hydrologic Calibration

- Considerations
 - tillage
 - cover crop
 - crop rotation
 - artificial drainage
- Limitations
 - extent of the ditch drainage network
 - tidal-flow gage.

Simulated and observed flows for January, 06 through July, 07.

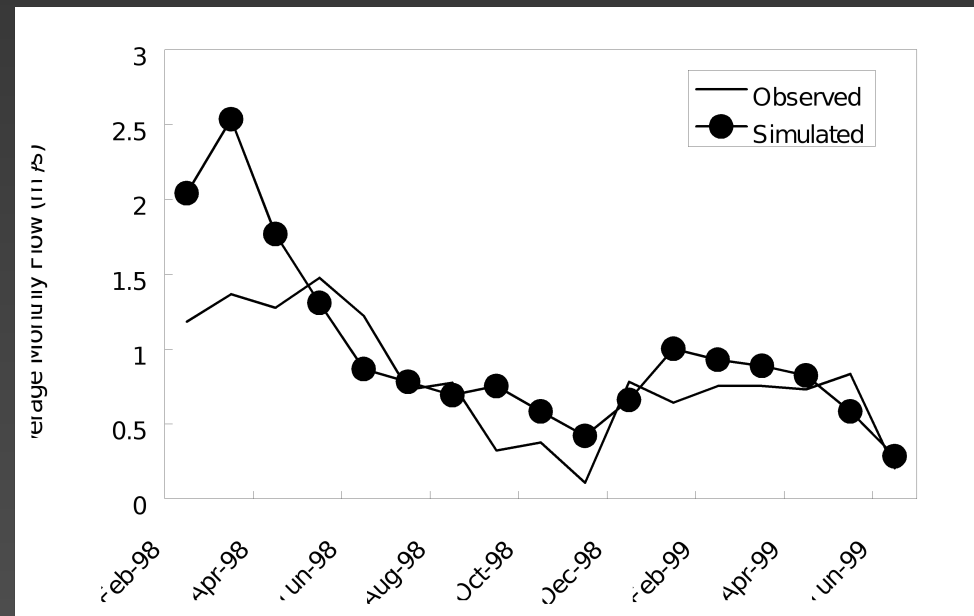




West Neck Creek Hydrologic Calibration

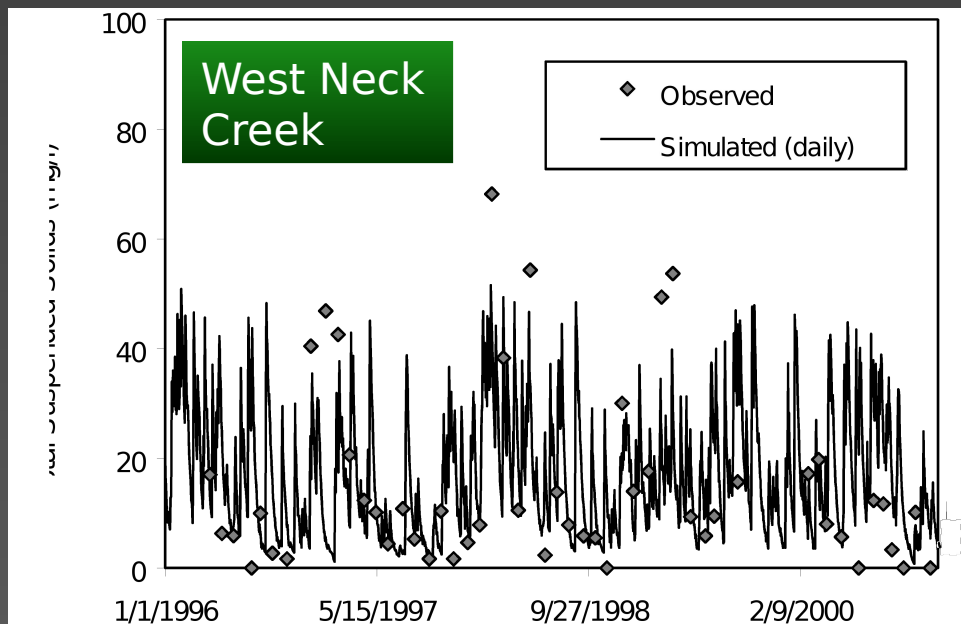
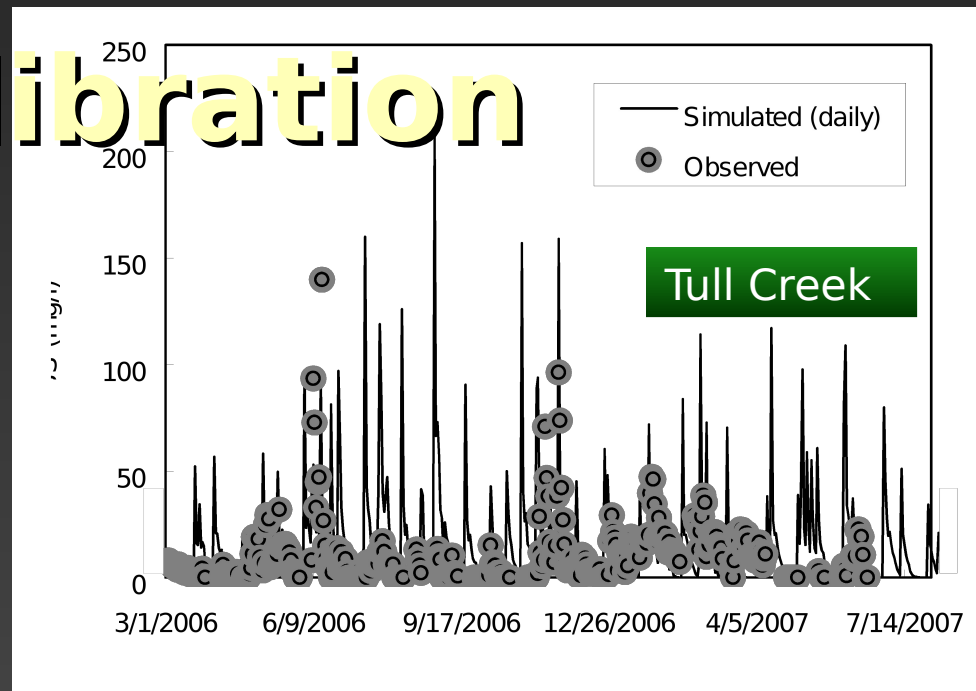
- Calibrated parameters for overlapping HRUs were applied
 - Agricultural drainage not simulated
- Limitations
 - Bi-directional flow
 - Wind direction and speed influence flow while precipitation alone has little effect on flow (Caldwell, 2001)

Simulated and observed flows for February 1998 through June 1999.



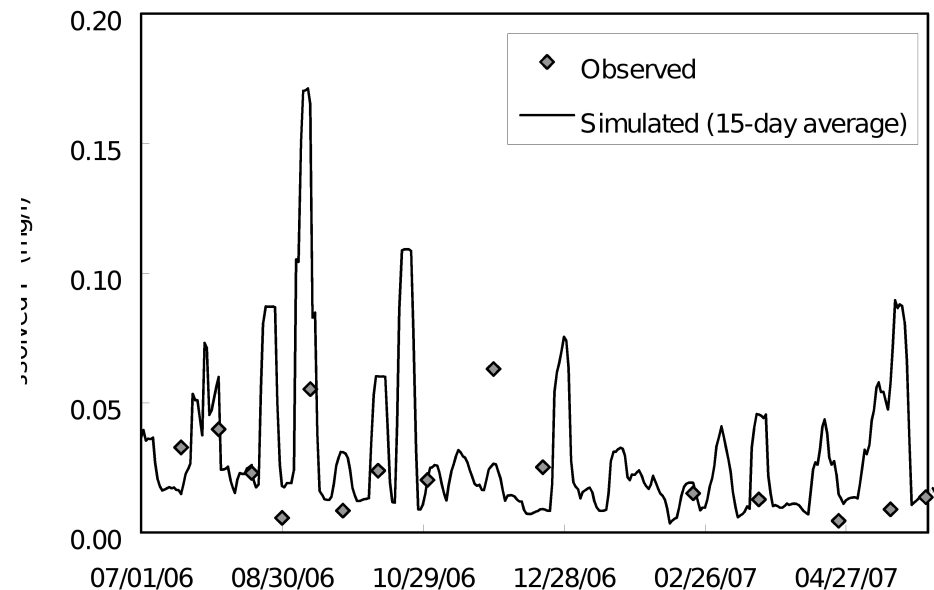
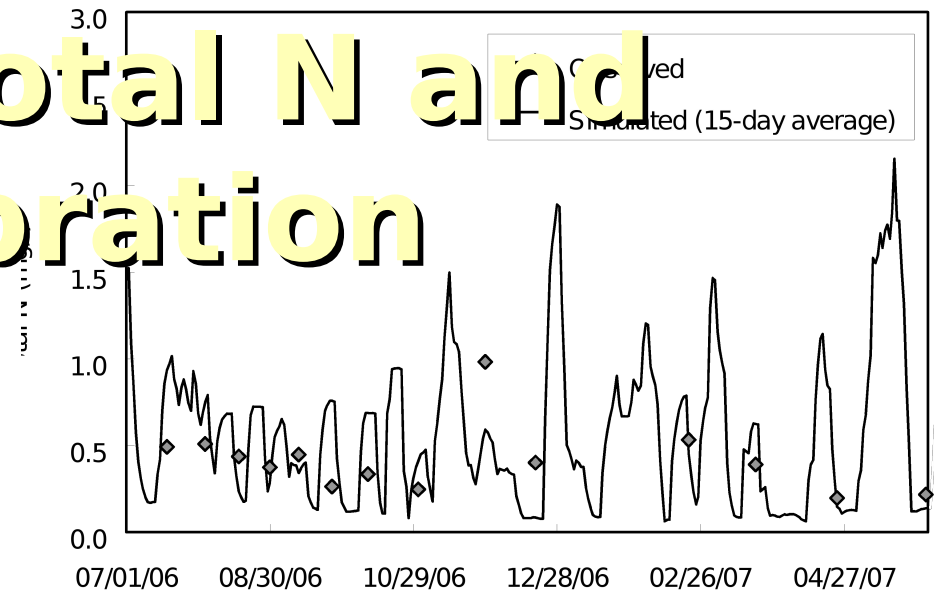
Sediment Calibration

- The surrogate total suspended solids data were used to calibrate sediment.
- Assumptions
 - filter strips in riparian areas
 - conservation tillage



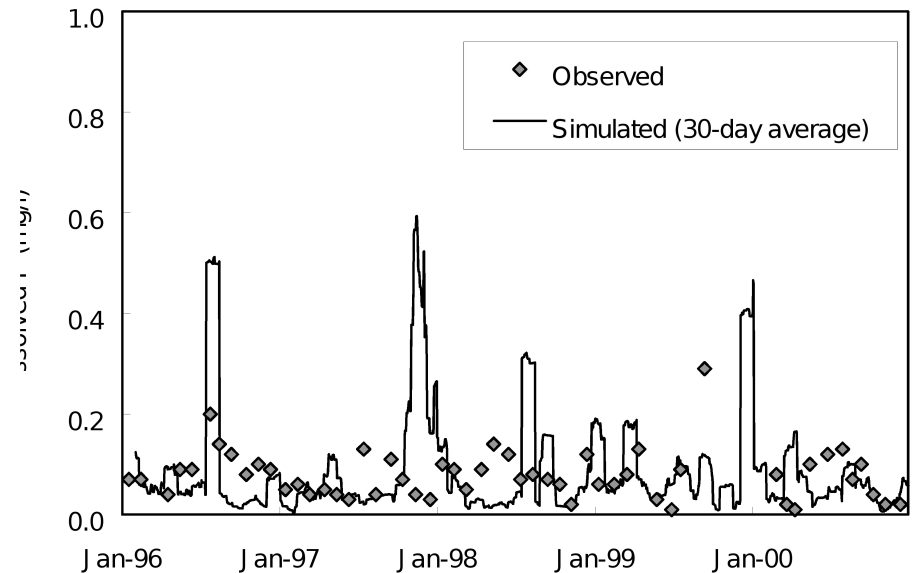
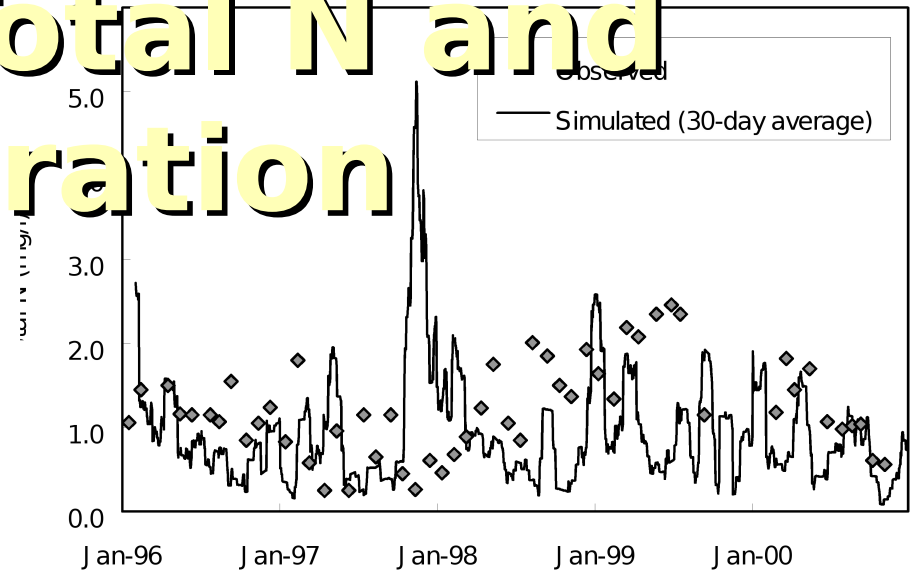
Tull Creek Total N and Total P Calibration

- Calibration performed by simulating and nitrogen components, specifically
 - organic nitrogen,
 - nitrite and nitrate and
 - ammonia.
- Data used for calibration was collected every two weeks, therefore a comparison to 15-day running average.
- Model tended to over estimate the nitrate component
- Marshlands and vegetated waterways in the watershed increase denitrification



West Neck Total N and Total P Calibration

- Water quality samples were collected once a month, therefore, 30-day running averages of simulated values were used for model evaluation
- Organic nitrogen concentrations were high (mean of 1.0 mg/L).
- Urban areas contributed significant organic nitrogen loads.
- Potential other sources could include wildlife waste, and contributions through the shallow groundwater.



Simulated and Observed Mean Concentrations

Variable	West Neck Creek			Tull Creek		
	Observed Mean	Simulated Mean	Mean Error	Observed Mean	Modeled Mean	Mean Error
TSS (mg/L)	16.04	16.65	3.8%	10.95	14.85	35.6%
Org N (mg/L)	0.99	0.17	-82.9%	0.16	0.15	-6.1%
NO3/NO2 (mg/L)	0.14	0.54	287.4%	0.14	0.29	106.2%
NH3 (mg/L)	0.08	0.20	135.2%	0.10	0.10	3.5%
Diss P (mg/L)	0.08	0.09	18.1%	0.02	0.04	65.3%
Total N (mg/L)	1.21	0.90	-25.3%	0.42	0.46	10.5%

Model Application

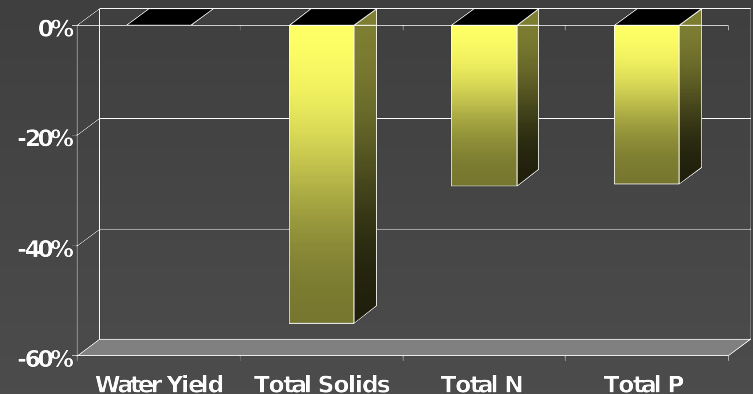
Water, total suspended solids, total nitrogen and total phosphorus yield estimates for 06-07

Parameter	Tull Creek	West Neck Creek	Percent Difference*
Water Yield (mm)	1005	570	-43%
Total Solids (metric tons/km ²)	44	13	-70%
Total N (kg//km ²)	1201	1406	17%
Total P (kg//km ²)	185	126	-32%

* From Tull Creek (agricultural watershed) to West Neck Creek (urban watershed)

Alternative Scenario

- A sediment BMP for agricultural lands lowered sediment and nutrient yield by 29 and 54 percent from the existing values.



Summary and Conclusions

- Model was configured to
 - simulate monthly positive stream flows
 - daily sediment concentrations and
 - mean dissolved phosphorus concentrations.
 - total nitrogen with some limitations.
- Low nutrient concentrations may be due to
 - marshlands that buffer both streams near the outlet process much of the nutrients.
- The model predicted that sediment yields would be higher in the agricultural watershed than in the urban watershed and higher